Statistical quality control

Statistical quality control (SQC) is defined as the application of the 14 statistical and analytical tools (7-QC and 7-SUPP) to monitor process outputs (dependent variables). Statistical process control (SPC) is the application of the same 14 tools to control process inputs (independent variables). Although both terms are often used interchangeably, SQC includes acceptance sampling where SPC does not.

## THE 7 QUALITY CONTROL (7-QC) TOOLS

In 1974, [Dr. Kaoru Ishikawa](https://asq.org/about-asq/honorary-members/ishikawa) brought together a collection of process improvement tools in his text Guide to Quality Control. Known around the world as the [seven quality control (7-QC) tools](https://asq.org/quality-resources/seven-basic-quality-tools), they are:

1. [Cause-and-effect diagram](https://asq.org/quality-resources/fishbone) (also called Ishikawa diagram or fishbone diagram)
2. [Check sheet](https://asq.org/quality-resources/check-sheet)
3. [Control chart](https://asq.org/quality-resources/control-chart)
4. [Histogram](https://asq.org/quality-resources/histogram)
5. [Pareto chart](https://asq.org/quality-resources/pareto)
6. [Scatter diagram](https://asq.org/quality-resources/scatter-diagram)
7. [Stratification](https://asq.org/quality-resources/stratification)

## THE 7 SUPPLEMENTAL (7-SUPP) TOOLS

In addition to the basic 7-QC tools, there are also some additional statistical quality tools known as the seven supplemental (7-SUPP) tools:

1. [Data stratification](https://asq.org/quality-resources/stratification)
2. Defect maps
3. Events logs
4. [Process flowcharts](https://asq.org/quality-resources/flowchart)
5. Progress centers
6. Randomization
7. Sample size determination

FISHBONE DIAGRAM

[Quality Glossary Definition: Fishbone diagram](https://asq.org/quality-resources/quality-glossary/f)

Fishbone Diagram5

Also called: cause-and-effect diagram, Ishikawa diagram

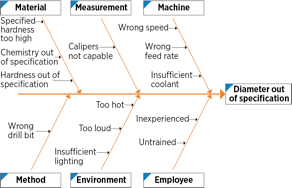
Variations: cause enumeration diagram, process fishbone, time-delay fishbone, CEDAC (cause-and-effect diagram with the addition of cards), desired-result fishbone, reverse fishbone diagram   
  
This [cause analysis tool](https://asq.org/quality-resources/root-cause-analysis/tools) is considered one of the [seven basic quality tools](https://asq.org/quality-resources/seven-basic-quality-tools). The fishbone diagram identifies many possible causes for an effect or problem. It can be used to structure a brainstorming session. It immediately sorts ideas into useful categories.

* [When to use a fishbone diagram](https://asq.org/quality-resources/fishbone#Use)
* [Fishbone diagram procedure](https://asq.org/quality-resources/fishbone#Procedure)
* [Fishbone diagram example](https://asq.org/quality-resources/fishbone#Example)
* [Create a fishbone diagram](https://asq.org/quality-resources/fishbone#Create)
* [Fishbone diagram resources](https://asq.org/quality-resources/fishbone#Resources)

WHEN TO USE A FISHBONE DIAGRAM

* When identifying possible causes for a problem
* When a team’s thinking tends to fall into ruts

FISHBONE DIAGRAM PROCEDURE



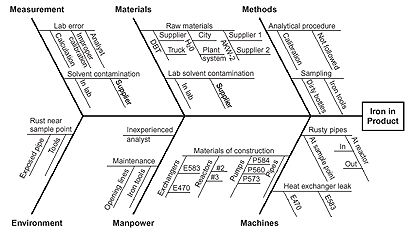
**Fishbone Diagram Example**

**Materials needed:** marking pens and flipchart or whiteboard.

1. Agree on a problem statement (effect). Write it at the center right of the flipchart or whiteboard. Draw a box around it and draw a horizontal arrow running to it.
2. Brainstorm the major categories of causes of the problem. If this is difficult use generic headings:
   * + Methods
     + Machines (equipment)
     + People (manpower)
     + Materials
     + Measurement
     + Environment
3. Write the categories of causes as branches from the main arrow.
4. Brainstorm all the possible causes of the problem. Ask "Why does this happen?" As each idea is given, the facilitator writes it as a branch from the appropriate category. Causes can be written in several places if they relate to several categories.
5. Again ask "Why does this happen?" about each cause. Write sub-causes branching off the causes. Continue to ask "Why?" and generate deeper levels of causes. Layers of branches indicate causal relationships.
6. When the group runs out of ideas, focus attention to places on the chart where ideas are few.

FISHBONE DIAGRAM EXAMPLE

This fishbone diagram was drawn by a manufacturing team to try to understand the source of periodic iron contamination. The team used the six generic headings to prompt ideas. Layers of branches show thorough thinking about the causes of the problem.



**Fishbone Diagram Example**

For example, under the heading "Machines," the idea "materials of construction" shows four kinds of equipment and then several specific machine numbers.

Note that some ideas appear in two different places. "Calibration" shows up under "Methods" as a factor in the analytical procedure, and also under "Measurement" as a cause of lab error. "Iron tools" can be considered a "Methods" problem when taking samples or a "Manpower" problem with maintenance personnel.

CHECK SHEET

[Quality Glossary Definition: Check sheet](https://asq.org/quality-resources/quality-glossary/c)

Also called: defect concentration diagram

A check sheet is a structured, prepared form for collecting and analyzing data. This is a generic [data collection and analysis tool](https://asq.org/quality-resources/data-collection-analysis-tools) that can be adapted for a wide variety of purposes and is considered one of the [seven basic quality tools](https://asq.org/quality-resources/seven-basic-quality-tools).

WHEN TO USE A CHECK SHEET

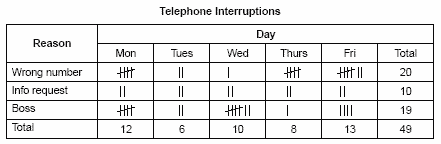
* When data can be observed and collected repeatedly by the same person or at the same location
* When collecting data on the frequency or patterns of events, problems, defects, defect location, defect causes, or similar issues
* When collecting data from a production process

CHECK SHEET PROCEDURE

1. Decide what event or problem will be observed. Develop operational definitions.
2. Decide when data will be collected and for how long.
3. Design the form. Set it up so that data can be recorded simply by making check marks or X's or similar symbols and so that data do not have to be recopied for analysis.
4. Label all spaces on the form.
5. Test the check sheet for a short trial period to be sure it collects the appropriate data and is easy to use.
6. Each time the targeted event or problem occurs, record data on the check sheet.

CHECK SHEET EXAMPLE

The figure below shows a check sheet used to collect data on telephone interruptions. The tick marks were added as data was collected over several weeks.



# CONTROL CHART

[Quality Glossary Definition: Control chart](https://asq.org/quality-resources/quality-glossary/c#cc)

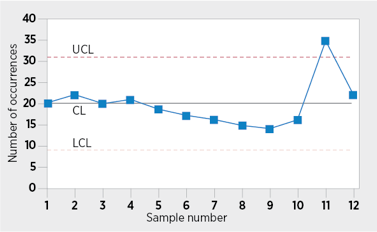
Also called: Shewhart chart, statistical process control chart

The control chart is a graph used to study how a process changes over time. Data are plotted in time order. A control chart always has a central line for the average, an upper line for the upper

control limit, and a lower line for the lower control limit. These lines are determined from historical data. By comparing current data to these lines, you can draw conclusions about whether the process variation is consistent (in control) or is unpredictable (out of control, affected by special causes of variation). This versatile [data collection and analysis tool](https://asq.org/quality-resources/data-collection-analysis-tools) can be used by a variety of industries and is considered one of the [seven basic quality tools](https://asq.org/quality-resources/seven-basic-quality-tools).

Control charts for variable data are used in pairs. The top chart monitors the average, or the centering of the distribution of data from the process. The bottom chart monitors the range, or the width of the distribution. If your data were shots in target practice, the average is where the shots are clustering, and the range is how tightly they are clustered. Control charts for attribute data are used singly.

* [When to use a control chart](https://asq.org/quality-resources/control-chart#Use)
* [Basic procedure](https://asq.org/quality-resources/control-chart#Procedure)
* [Create a control chart](https://asq.org/quality-resources/control-chart#Create)
* [Control chart resources](https://asq.org/quality-resources/control-chart#Resources)



**Control Chart Example**

## WHEN TO USE A CONTROL CHART

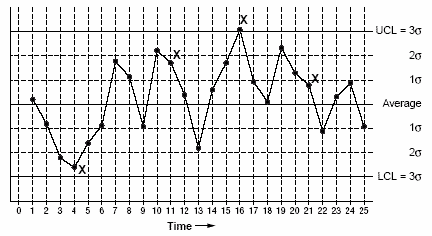
* When controlling ongoing processes by finding and correcting problems as they occur
* When predicting the expected range of outcomes from a process
* When determining whether a process is stable (in statistical control)
* When analyzing patterns of process variation from special causes (non-routine events) or common causes (built into the process)
* When determining whether your quality improvement project should aim to prevent specific problems or to make fundamental changes to the process

## BASIC PROCEDURE

1. Choose the appropriate control chart for your data.
2. Determine the appropriate time period for collecting and plotting data.
3. Collect data, construct your chart and analyze the data.
4. Look for "out-of-control signals" on the control chart. When one is identified, mark it on the chart and investigate the cause. Document how you investigated, what you learned, the cause and how it was corrected.

### Out-of-control signals

* + A single point outside the control limits. In Figure 1, point sixteen is above the UCL (upper control limit).
  + Two out of three successive points are on the same side of the centerline and farther than 2 σ from it. In Figure 1, point 4 sends that signal.
  + Four out of five successive points are on the same side of the centerline and farther than 1 σ from it. In Figure 1, point 11 sends that signal.
  + A run of eight in a row are on the same side of the centerline. Or 10 out of 11, 12 out of 14, or 16 out of 20. In Figure 1, point 21 is eighth in a row above the centerline.
  + Obvious consistent or persistent patterns that suggest something unusual about your data and your process.



**Figure 1 Control Chart: Out-of-Control Signals**

1. Continue to plot data as they are generated. As each new data point is plotted, check for new out-of-control signals.
2. When you start a new control chart, the process may be out of control. If so, the control limits calculated from the first 20 points are conditional limits. When you have at least 20 sequential points from a period when the process is operating in control, recalculate control limits.

# WHAT IS A HISTOGRAM?

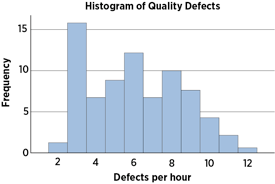
[Quality Glossary Definition: Histogram](https://asq.org/quality-resources/quality-glossary/h)

A frequency distribution shows how often each different value in a set of data occurs. A histogram is the most commonly used graph to show frequency distributions. It looks very much like a bar chart, but there are important differences between them. This helpful [data collection and analysis tool](https://asq.org/quality-resources/data-collection-analysis-tools) is considered one of the [seven basic quality tools](https://asq.org/quality-resources/seven-basic-quality-tools).

## WHEN TO USE A HISTOGRAM

Use a histogram when:

* The data are numerical
* You want to see the shape of the data’s distribution, especially when determining whether the output of a process is distributed approximately normally
* Analyzing whether a process can meet the customer’s requirements
* Analyzing what the output from a supplier’s process looks like
* Seeing whether a process change has occurred from one time period to another
* Determining whether the outputs of two or more processes are different
* You wish to communicate the distribution of data quickly and easily to others



**Histogram Example**

## HOW TO CREATE A HISTOGRAM

1. Collect at least 50 consecutive data points from a process.
2. Use a [histogram worksheet](https://asq.org/quality-resources/histogram#Worksheet) to set up the histogram. It will help you determine the number of bars, the range of numbers that go into each bar, and the labels for the bar edges. After calculating W in Step 2 of the worksheet, use your judgment to adjust it to a convenient number. For example, you might decide to round 0.9 to an even 1.0. The value for W must not have more decimal places than the numbers you will be graphing.
3. Draw x- and y-axes on graph paper. Mark and label the y-axis for counting data values. Mark and label the x-axis with the L values from the worksheet. The spaces between these numbers will be the bars of the histogram. Do not allow for spaces between bars.
4. For each data point, mark off one count above the appropriate bar with an X or by shading that portion of the bar.

## HISTOGRAM ANALYSIS

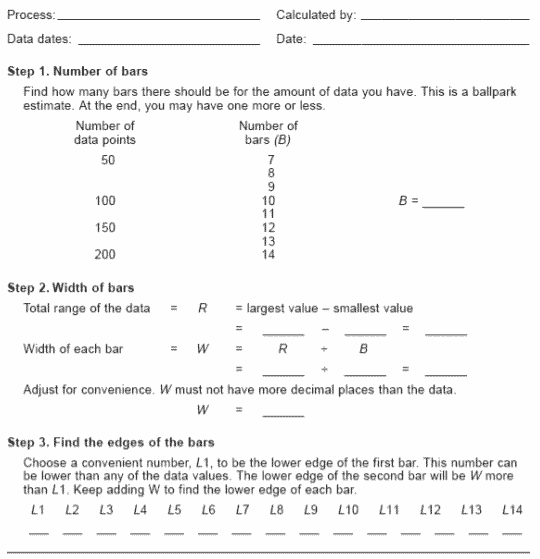
* Before drawing any conclusions from your histogram, be sure that the process was operating normally during the time period being studied. If any unusual events affected the process during the time period of the histogram, your analysis of the histogram shape likely cannot be generalized to all time periods.
* Analyze the meaning of your histogram's shape. Typical histogram [shapes and what they mean](https://asq.org/quality-resources/histogram#Shapes) are covered below.

## HISTOGRAM TOOLS & TEMPLATES

[Histogram template](https://asq.org/-/media/public/learn-about-quality/data-collection-analysis-tools/data-point-histogram.xls) (Excel) Analyze the frequency distribution of up to 200 data points using this simple, but powerful, histogram generating tool.

[Check sheet template](https://asq.org/-/media/public/learn-about-quality/data-collection-analysis-tools/check-sheet-histogram.xls) (Excel) Analyze the number of defects for each day of the week. Start by tracking the defects on the check sheet. The tool will create a histogram using the data you enter.

## HISTOGRAM WORKSHEET EXAMPLE

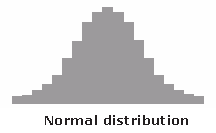


## TYPICAL HISTOGRAM SHAPES AND WHAT THEY MEAN

### Normal Distribution

A common pattern is the bell-shaped curve known as the "normal distribution." In a normal or "typical" distribution, points are as likely to occur on one side of the average as on the other. Note that other distributions look similar to the normal distribution. Statistical calculations must be used to prove a normal distribution.

It's important to note that "normal" refers to the typical distribution for a particular process. For example, many processes have a natural limit on one side and will produce skewed distributions. This is normal—meaning typical—for those processes, even if the distribution isn’t considered "normal."



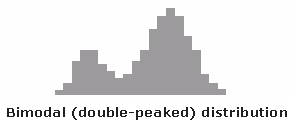
### Skewed Distribution

The skewed distribution is asymmetrical because a natural limit prevents outcomes on one side. The distribution’s peak is off center toward the limit and a tail stretches away from it. For example, a distribution of analyses of a very pure product would be skewed, because the product cannot be more than 100 percent pure. Other examples of natural limits are holes that cannot be smaller than the diameter of the drill bit or call-handling times that cannot be less than zero. These distributions are called right- or left-skewed according to the direction of the tail.



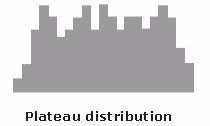
### Double-Peaked or Bimodal

The bimodal distribution looks like the back of a two-humped camel. The outcomes of two processes with different distributions are combined in one set of data. For example, a distribution of production data from a two-shift operation might be bimodal, if each shift produces a different distribution of results. Stratification often reveals this problem.



### Plateau or Multimodal Distribution

The plateau might be called a “multimodal distribution.” Several processes with normal distributions are combined. Because there are many peaks close together, the top of the distribution resembles a plateau.



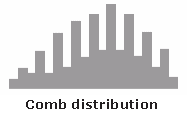
### Edge Peak Distribution

The edge peak distribution looks like the normal distribution except that it has a large peak at one tail. Usually this is caused by faulty construction of the histogram, with data lumped together into a group labeled “greater than.”



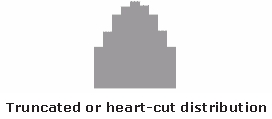
### Comb Distribution

In a comb distribution, the bars are alternately tall and short. This distribution often results from rounded-off data and/or an incorrectly constructed histogram. For example, temperature data rounded off to the nearest 0.2 degree would show a comb shape if the bar width for the histogram were 0.1 degree.



### Truncated or Heart-Cut Distribution

The truncated distribution looks like a normal distribution with the tails cut off. The supplier might be producing a normal distribution of material and then relying on inspection to separate what is within specification limits from what is out of spec. The resulting shipments to the customer from inside the specifications are the heart cut.



### Dog Food Distribution

The dog food distribution is missing something—results near the average. If a customer receives this kind of distribution, someone else is receiving a heart cut and the customer is left with the “dog food,” the odds and ends left over after the master’s meal. Even though what the customer receives is within specifications, the product falls into two clusters: one near the upper specification limit and one near the lower specification limit. This variation often causes problems in the customer’s process.



WHAT IS A PARETO CHART?

[Quality Glossary Definition: Pareto chart](https://asq.org/quality-resources/quality-glossary/p)

Also called: Pareto diagram, Pareto analysis

Variations: weighted Pareto chart, comparative Pareto charts

A Pareto chart is a bar graph. The lengths of the bars represent frequency or cost (time or money), and are arranged with longest bars on the left and the shortest to the right. In this way the chart visually depicts which situations are more significant. This [cause analysis tool](https://asq.org/quality-resources/root-cause-analysis/tools) is considered one of the [seven basic quality tools](https://asq.org/quality-resources/seven-basic-quality-tools).

* [When to use a Pareto chart](https://asq.org/quality-resources/pareto#Use)
* [Pareto chart procedure](https://asq.org/quality-resources/pareto#Procedure)
* [Pareto chart examples](https://asq.org/quality-resources/pareto#Examples)
* [Create a Pareto chart](https://asq.org/quality-resources/pareto#Create)
* [Pareto chart resources](https://asq.org/quality-resources/pareto#Resources)

WHEN TO USE A PARETO CHART

* When analyzing data about the frequency of problems or causes in a process
* When there are many problems or causes and you want to focus on the most significant
* When analyzing broad causes by looking at their specific components
* When communicating with others about your data

PARETO CHART PROCEDURE

1. Decide what categories you will use to group items.
2. Decide what measurement is appropriate. Common measurements are frequency, quantity, cost and time.
3. Decide what period of time the Pareto chart will cover: One work cycle? One full day? A week?
4. Collect the data, recording the category each time, or assemble data that already exist.
5. Subtotal the measurements for each category.
6. Determine the appropriate scale for the measurements you have collected. The maximum value will be the largest subtotal from step 5. (If you will do optional steps 8 and 9 below, the maximum value will be the sum of all subtotals from step 5.) Mark the scale on the left side of the chart.
7. Construct and label bars for each category. Place the tallest at the far left, then the next tallest to its right, and so on. If there are many categories with small measurements, they can be grouped as “other.”

**Note:** Steps 8 and 9 are optional but are useful for analysis and communication.

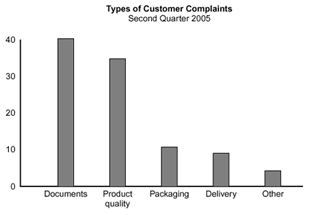
1. Calculate the percentage for each category: the subtotal for that category divided by the total for all categories. Draw a right vertical axis and label it with percentages. Be sure the two scales match. For example, the left measurement that corresponds to one-half should be exactly opposite 50% on the right scale.
2. Calculate and draw cumulative sums: add the subtotals for the first and second categories, and place a dot above the second bar indicating that sum. To that sum add the subtotal for the third category, and place a dot above the third bar for that new sum. Continue the process for all the bars. Connect the dots, starting at the top of the first bar. The last dot should reach 100% on the right scale.

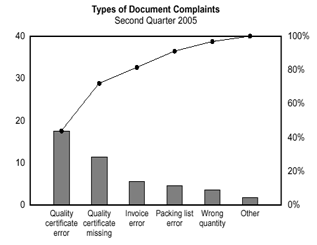
PARETO CHART EXAMPLES

Figure 1 shows how many customer complaints were received in each of five categories.

Figure 2 takes the largest category, "documents," from Figure 1, breaks it down into six categories of document-related complaints, and shows cumulative values.

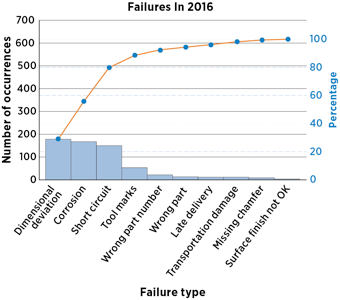
If all complaints cause equal distress to the customer, working on eliminating document-related complaints would have the most impact, and of those, working on quality certificates should be most fruitful.

  
**Figure 1: Pareto Chart, Customer Complaints**

  
**Figure 2: Pareto Chart, Document Complaints**

CREATE A PARETO CHART

Use the [Pareto chart template](https://asq.org/-/media/public/learn-about-quality/data-collection-analysis-tools/data-analysis.xls?la=en) (Excel) to create a Pareto chart and analyze the occurrences of up to 10 defects by entering the defects on the check sheet.



**Pareto Chart Template Example**

# WHAT IS A SCATTER DIAGRAM?

[Quality Glossary Definition: Scatter diagram](https://asq.org/quality-resources/quality-glossary/s)

Also called: scatter plot, X-Y graph

The scatter diagram graphs pairs of numerical data, with one variable on each axis, to look for a relationship between them. If the variables are correlated, the points will fall along a line or curve. The better the correlation, the tighter the points will hug the line. This [cause analysis tool](https://asq.org/quality-resources/root-cause-analysis/tools)is considered one of the [seven basic quality tools](https://asq.org/quality-resources/seven-basic-quality-tools).

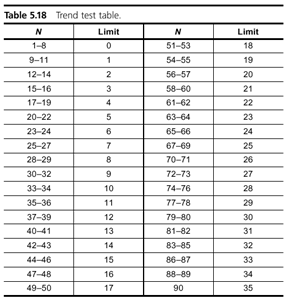
* [When to use a scatter diagram](https://asq.org/quality-resources/scatter-diagram#Use)
* [Scatter diagram procedure](https://asq.org/quality-resources/scatter-diagram#Procedure)
* [Scatter diagram example](https://asq.org/quality-resources/scatter-diagram#Example)
* [Scatter diagram considerations](https://asq.org/quality-resources/scatter-diagram#Considerations)
* [Scatter diagram resources](https://asq.org/quality-resources/scatter-diagram#Resources)

## WHEN TO USE A SCATTER DIAGRAM

* When you have paired numerical data
* When your dependent variable may have multiple values for each value of your independent variable
* When trying to determine whether the two variables are related, such as:
  + When trying to identify potential [root causes](https://asq.org/quality-resources/root-cause-analysis) of problems
  + After [brainstorming](https://asq.org/quality-resources/brainstorming) causes and effects using a [fishbone diagram](https://asq.org/quality-resources/fishbone) to determine objectively whether a particular cause and effect are related
  + When determining whether two effects that appear to be related both occur with the same cause
  + When testing for autocorrelation before constructing a [control chart](https://asq.org/quality-resources/control-chart)

## SCATTER DIAGRAM PROCEDURE

1. Collect pairs of data where a relationship is suspected.
2. Draw a graph with the independent variable on the horizontal axis and the dependent variable on the vertical axis. For each pair of data, put a dot or a symbol where the x-axis value intersects the y-axis value. (If two dots fall together, put them side by side, touching, so that you can see both.)
3. Look at the pattern of points to see if a relationship is obvious. If the data clearly form a line or a curve, you may stop because variables are correlated. You may wish to use regression or correlation analysis now. Otherwise, complete steps 4 through 7.
4. Divide points on the graph into four quadrants. If there are X points on the graph:  
   * Count X/2 points from top to bottom and draw a horizontal line.
   * Count X/2 points from left to right and draw a vertical line.
   * If number of points is odd, draw the line through the middle point.
5. Count the points in each quadrant. Do not count points on a line.
6. Add the diagonally opposite quadrants. Find the smaller sum and the total of points in all quadrants.  
   A = points in upper left + points in lower right  
   B = points in upper right + points in lower left  
   Q = the smaller of A and B  
   N = A + B
7. Look up the limit for N on the trend test table.  
   * If Q is less than the limit, the two variables are related.
   * If Q is greater than or equal to the limit, the pattern could have occurred from random chance.



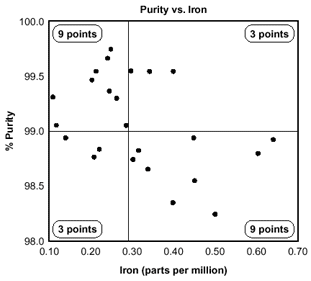
## SCATTER DIAGRAM EXAMPLE

The ZZ-400 manufacturing team suspects a relationship between product purity (percent purity) and the amount of iron (measured in parts per million or ppm). Purity and iron are plotted against each other as a scatter diagram, as shown in the figure below.

There are 24 data points. Median lines are drawn so that 12 points fall on each side for both percent purity and ppm iron.

To test for a relationship, they calculate:  
A = points in upper left + points in lower right = 9 + 9 = 18  
B = points in upper right + points in lower left = 3 + 3 = 6  
Q = the smaller of A and B = the smaller of 18 and 6 = 6  
N = A + B = 18 + 6 = 24

Then they look up the limit for N on the trend test table. For N = 24, the limit is 6.  
Q is equal to the limit. Therefore, the pattern could have occurred from random chance, and no relationship is demonstrated.

  
**Scatter Diagram Example**

### Additional Scatter Diagram Examples

Below are some examples of situations in which might you use a scatter diagram:

* Variable A is the temperature of a reaction after 15 minutes. Variable B measures the color of the product. You suspect higher temperature makes the product darker. Plot temperature and color on a scatter diagram.
* Variable A is the number of employees trained on new software, and variable B is the number of calls to the computer help line. You suspect that more training reduces the number of calls. Plot number of people trained versus number of calls.
* To test for autocorrelation of a measurement being monitored on a control chart, plot this pair of variables: Variable A is the measurement at a given time. Variable B is the same measurement, but at the previous time. If the scatter diagram shows correlation, do another diagram where variable B is the measurement two times previously. Keep increasing the separation between the two times until the scatter diagram shows no correlation.

## SCATTER DIAGRAM CONSIDERATIONS

* Even if the scatter diagram shows a relationship, do not assume that one variable caused the other. Both may be influenced by a third variable.
* When the data are plotted, the more the diagram resembles a straight line, the stronger the relationship.
* If a line is not clear, statistics (N and Q) determine whether there is reasonable certainty that a relationship exists. If the statistics say that no relationship exists, the pattern could have occurred by random chance.
* If the scatter diagram shows no relationship between the variables, consider whether the data might be stratified.
* If the diagram shows no relationship, consider whether the independent (x-axis) variable has been varied widely. Sometimes a relationship is not apparent because the data do not cover a wide enough range.

WHAT IS STRATIFICATION?

[Quality Glossary Definition: Stratification](https://asq.org/quality-resources/quality-glossary/s)

Stratification is defined as the act of sorting data, people, and objects into distinct groups or layers. It is a technique used in combination with other data analysis tools. When data from a variety of sources or categories have been lumped together, the meaning of the data can be difficult to see. This [data collection and analysis technique](https://asq.org/quality-resources/data-collection-analysis-tools) separates the data so that patterns can be seen and is considered one of the [seven basic quality tools](https://asq.org/quality-resources/seven-basic-quality-tools).

WHEN TO USE STRATIFICATION

* Before collecting data
* When data come from several sources or conditions, such as shifts, days of the week, suppliers, or population groups
* When data analysis may require separating different sources or conditions

Here are examples of different sources that might require data to be stratified:

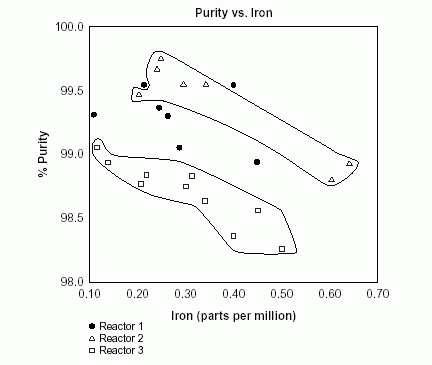
* Equipment
* Shifts
* Departments
* Materials
* Suppliers
* Day of the week
* Time of day
* Products

STRATIFICATION PROCEDURE

1. Before collecting data, consider which information about the sources of the data might have an effect on the results. Set up the data collection so that you collect that information as well.
2. When plotting or graphing the collected data on a [scatter diagram](https://asq.org/quality-resources/scatter-diagram), [control chart](https://asq.org/quality-resources/control-chart), [histogram](https://asq.org/quality-resources/histogram), or other analysis tool, use different marks or colors to distinguish data from various sources. Data that are distinguished in this way are said to be "stratified."
3. Analyze the subsets of stratified data separately. For example, on a scatter diagram where data are stratified into data from source 1 and data from source 2, draw quadrants, count points, and determine the critical value only for the data from source 1, then only for the data from source 2.

STRATIFICATION EXAMPLE

The ZZ-400 manufacturing team drew a scatter diagram to test whether product purity and iron contamination were related, but the plot did not demonstrate a relationship. Then a team member realized that the data came from three different reactors. The team member redrew the diagram, using a different symbol for each reactor’s data (Figure 1).

  
**Figure 1: Stratification Diagram**

Now patterns can be seen. The data from reactor 2 and reactor 3 are circled. Even without doing any calculations, it is clear that for those two reactors, purity decreases as iron increases. However, the data from reactor 1, the solid dots that are not circled, do not show that relationship. Something is different about reactor 1.

Quality Assurance Certifications:

There are several certifications available in the industry to ensure that Organizations follow Standards Quality Processes. Customers make this as qualifying criteria while selecting a software vendor.

ISO 9000

This standard was first established in 1987, and it is related to Quality Management Systems. This helps the organization ensure quality to their customers and other stakeholders. An organization who wishes to be certified as ISO 9000 is audited based on their functions, products, services and their processes. The main objective is to review and verify whether the organization is following the process as expected and check whether existing processes need improvement.

This certification helps -

• Increase the profit of the organization

• Improves Domestic and International trade

• Reduces waste and increase the productivity of the employees

• Provide Excellent customer satisfaction

CMMI level

The Capability Maturity Model Integrated (CMMI) is a process improvement approach developed specially for software process improvement. It is based on the process maturity framework and used as a general aid in business processes in the Software Industry. This model is highly regarded and widely used in Software Development Organizations.

CMMI has 5 levels. An organization is certified at CMMI level 1 to 5 based on the maturity of their Quality Assurance Mechanisms.

• Level 1 - Initial: In this stage the quality environment is unstable. Simply, no processes have been followed or documented

• Level 2 - Repeatable: Some processes are followed which are repeatable. This level ensures processes are followed at the project level.

• Level 3 - Defined: Set of processes are defined and documented at the organizational level. Those defined processes are subject to some degree of improvement.

• Level 4 - Managed: This level uses process metrics and effectively controls the processes that are followed.

• Level 5 - Optimizing: This level focuses on the continuous improvements of the processes through learning & innovation.

Test Maturity Model (TMM):

This model assesses the maturity of processes in a Testing Environment. Even this model has 5 levels, defined below-

• Level 1 - Initial: There is no quality standard followed for testing processes and only ad-hoc methods are used at this level

• Level 2 - Definition: Defined process. Preparation of test strategy, plans, test cases are done.

• Level 3 - Integration: Testing is carried out throughout the software development lifecycle (SDLC) - which is nothing but integration with the development activities, E.g., V- Model.

• Level 4 - Management and Measurement: Review of requirements and designs takes place at this level and criteria has been set for each level of testing

• Level 5 - Optimization: Many preventive techniques are used for testing processes, and tool support (Automation) is used to improve the testing standards and processes.

Conclusion:

Quality Assurance is to check whether the product developed is fit for use. For that, Organization should have processes and standards to be followed which need to be improved on a periodic basis. It concentrates mainly on the quality of product/service that we are providing to the customers during or after implementation of software.

**What Is Process Documentation?**

Process documentation is a detailed description of how to execute a process. The process document outlines the exact steps needed to complete a task or process from start to finish.

The area of process documentation triggers on how employee members perform the process, and not what the process is. Process documentation is important for any business because it enhances consistency and lets your staff learn from both their successes and their mistakes.

Benefits of Process Documentation

Process documentation helps in:

Saving time & money

Reducing errors

Creating standardization

Improving employee onboarding

Creating workplace efficiencies

Finding additional ways to further improve processes

Improving workflows analytically

A lady putting documents in a file storage box Process documentation is an ongoing documentation of a process while a project or task is being carried out and in no way, is the final report. It helps analyze every step of a process and provide context to improve the process.

Every organization aspires to be successful and grow with time. The only way of knowing whether the business process you are employing is good enough is to keep tabs on each and every step and analyze, get feedback and suggest changes to improve. Only then the business will be able to run at its full capacity and grow faster.

Why You Need Process Documentation?

When it comes down to creating new processes or refining existing ones, there’s no better way to do it than to document the processes. The following are primary benefits that an organization seeks to achieve by documenting their processes:

1. Improving a Process

Most companies use repeatable business processes to get work done. People often downplay writing down steps to a process and rely on their “memory” or “guesswork” to perform tasks.

This is often the recipe for disaster. You are highly unlikely to make improvements to the process if you are unaware of:

What business processes are taking place

What the role of each step is in a process

What the role of your co-workers is in the process cycle

How the process impacts the overall bottom line of the business

To know what to do, you must know where to start.

Process documentation, thus, provides the eagle-eye view to a process and helps businesses figure out new strategies and tactics to create efficiencies in the workplace.

2. Use it as Training Material

Process documentation also acts as an essential training guide for new employees. Documentation acts as a “syllabus” for new hires and gets them up to speed with their new roles.

A boss ordering his employee to create document

This saves a significant amount of time for managers who would otherwise need to explain detailed processes to new hires.

It accelerates the learning curve exponentially and provides all the resources needed to understand the workflow in one place. It helps them understand their role and how it fits into the overall organization.

Read more: How To Create An Incredible Training Manual (Template Included)

3. Reduce Operational Ambiguity

Another key reason for documenting processes is to remove any sort of ambiguity of role and responsibility in the workplace. Business process documents clearly state:

Tasks required to complete a process

Individual roles and responsibilities

The person assigned to do the task

How to perform the task

This documented methodology reduces a lot of confusion in the workplace.

Anyone can access the process document anytime as it acts as a central repository for knowledge and information for the whole organization. This type of transparency stops any sort of tension from building within teams.

4. Preserve Key Knowledge

One often overlooked benefit of process documentation is its ability to preserve vital information and knowledge.

Knowledge booster icons By making a note of each and every step, everyone in the team knows how a particular process is carried out. So when a “high profile” or a critical employee leave, he/she doesn’t take the process knowledge with them.

5. Analysis

Process documentation makes it easier for management teams to analyze and compare previous versions of a process with new ones and calculate efficiency, reduced costs, and analyze other important metrics.

It helps management find whether their efforts are reaping the results they hoped for or should they try a different approach.

The learnings from process documentation can also be replicated to other processes, which can save a lot of time and money.

What Is The Aim Of Process Documentation?

A lady telling the aim of creating documents

The aim or goal of process documentation is to keep track of an ongoing process for the purpose of improving it in the future. The idea is to learn from the documentation, analyze the steps taken, and suggest changes and improvements.

Process documentation helps in:

Improving process efficiency

Locating flaws

Improving process quality

Improves the time taken to complete a process

Reduces costs

Provides a line of sight to employees involved

Read more: What is a Software Requirements Document

Who Are All Involved In Process Documentation?

Business process documentation involves three parties:

The Internal team (aka project team)

The stakeholders

The external parties

1. The Project Team

The project team holds responsibility for process documentation. Documenting the process while performing it makes sure that the project team is conscious of their efforts and are constantly learning.

A man uploading documents in a software It also makes sure that none of the steps in a process goes unnoticed and is recorded properly. However, you can also hire or put a specialist on the team just for the purpose of documenting the processes.

In this way, the project team does not have to interrupt their flow from time to time to document each and every step- the specialist can take care of that from a distance.

Read more: 20 Best Online Collaboration Tools For Teams

2. The Stakeholders

A stakeholder is someone who has a direct or indirect interest in a company. A stakeholder is any person, organization, social group, or society at large.

Any stakeholders involved in a specific project should be involved in process documentation. This helps them analyze the steps taken in any process and give feedback or suggestions accordingly.

3. The External Parties

You can even involve outsiders a part of your process documentation.

This helps in getting an unbiased and fair judgment of the business practices and provides a new perspective. Observing things from a distance at times provides clarity and the ability to find more efficient ways of doing something.

How To Create Process Documentation?

Process documentation’s complexity depends upon the scale of the process being documented. If its a shorter process, its relatively easier to document a process as it involves a smaller number of people, stakeholders and the overall number of steps.

Needs for creating process documentation

However, if it’s a broad-scope process, involving internal as well as external stakeholders from different departments and specialties, process documentation can turn out to be fairly complex.

Therefore, we need to have certain guidelines or roadmap in place to make sure that process documentation is carried out effectively, irrespective of process size and scope.

The following are some key steps your team should incorporate while preparing for a business process documentation.

1. Scope

First and foremost, determine the scope of the process document. The scope answers questions like which process will be covered, what are the goals of the project, what changes are to be made (if any), etc.

2. Resources needed

Describe the resources that the team needs in order to complete the process you want to describe (inputs required). You also need to describe the outputs or what is being produced at the end of process documentation.

3. Know your audience

If you don’t know who your audience is and what their expectations are from the process documentation, you are wasting your time. Only when you are familiar with the audience can you create a document that meets their requirements.

4. Describe the team involved

Describe the team members involved in a process. Describe their roles and responsibility to establish clarity.

5. Collect information

Information is often collected through a brainstorming session about the steps required to complete an activity amongst the team members involved. It can also involve the views or expertise of stakeholders and outsiders.

6. Putting it all together

After you have made sure that all the steps required to perform a process from start to finish are noted, it’s time to organize them in a sequential list format.

A man writing down all the pointers

Make sure the steps are organized in the actual manner in which they work (process) is done. Write down the steps in a clear, concise way to be useful to your co-workers. Make the process documents easy to read by using bullets, headings, tables, charts, etc.

7. Flowchart

It’s now time to visualize the list of activities for your team in terms of a flowchart. Visually representing the steps involved in a process provides an easy way for outsiders and people from other departments to understand how a process is carried out. It also aids new employees to soak in information quickly and get up to speed with the work.

8. Get feedback

Share the process documentation with fellow colleagues and stakeholders and have them try to perform the process on their own.

This is a critical step in your documentation process as it helps to determine potential loopholes or corrections in the documentation by allowing outsider’s perspective to the document.

The visual representation of the process helps team members to see the process in a different light and find out if they missed something.

9. Improve

A man making improvements through process documentation It’s time to optimize the steps and add any improvements suggested by colleagues, stakeholders or fellow team members.

Rinse and repeat until your process is completely optimized and efficient. Keep adding changes to the document when you find a new strategy technique or tactic to improve your process.

10. Make it available

Once you are satisfied with the results, make the documentation available to relevant employees and stakeholders of the company. Ask them to freely provide their valuable suggestions and feedback.

Process Documentation Template to make life easy!

To make this procedure as easy as a breeze, we have got a well-equipped template for you! With this process documentation template, you do not have to worry about any of the do’s and don’ts, just a few simple clicks and Boom! it’s ready.

**Capability Maturity Model (CMM) & it's Levels in Software Engineering**

What is CMM?

Capability Maturity Model is used as a benchmark to measure the maturity of an organization's software process.

CMM was developed at the Software engineering institute in the late 80's. It was developed as a result of a study financed by the U.S Air Force as a way to evaluate the work of subcontractors. Later based on the CMM-SW model created in 1991 to assess the maturity of software development, multiple other models are integrated with CMM-I they are

Capability Maturity Model (CMM) & CMM Levels: A Fool’s Guide

In this tutorial, we will learn,

What is Capability Maturity Model (CMM) Levels?

What happens at different levels of CMM?

How long does it Take to Implement CMM?

Internal Structure of CMM

Limitations of CMM Models

Why Use CMM?

Primis Player Placeholder

What is Capability Maturity Model (CMM) Levels?

Initial

Repeatable/Managed

Defined

Quantitatively Managed

Optimizing

Capability Maturity Model (CMM) & CMM Levels: A Fool’s Guide

What happens at different levels of CMM?

Levels Activities Benefits

Level 1 Initial

At level 1, the process is usually chaotic and ad hoc

A capability is characterized on the basis of the individuals and not of the organization

Progress not measured

Products developed are often schedule and over budget

Wide variations in the schedule, cost, functionality, and quality targets

None. A project is Total Chaos

Level 2 Managed

Requirement Management

Estimate project parameters like cost, schedule, and functionality

Measure actual progress

Develop plans and process

Software project standards are defined

Identify and control products, problem reports changes, etc.

Processes may differ between projects

Processes become easier to comprehend

Managers and team members spend less time in explaining how things are done and more time in executing it

Projects are better estimated, better planned and more flexible

Quality is integrated into projects

Costing might be high initially but goes down overtime

Ask more paperwork and documentation

Level-3 Defined

Clarify customer requirements

Solve design requirements, develop an implementation process

Makes sure that product meets the requirements and intended use

Analyze decisions systematically

Rectify and control potential problems

Process Improvement becomes the standard

Solution progresses from being "coded" to being "engineered"

Quality gates appear throughout the project effort with the entire team involved in the process

Risks are mitigated and don't take the team by surprise

Level-4 Quantitatively Managed

Manages the project's processes and sub-processes statistically

Understand process performance, quantitatively manage the organization's project

Optimizes Process Performance across the organization

Fosters Quantitative Project Management in an organization.

Level-5 Optimizing

Detect and remove the cause of defects early

Identify and deploy new tools and process improvements to meet needs and business objectives

Fosters Organizational Innovation and Deployment

Gives impetus to Causal Analysis and Resolution

Following diagram, gives a pictorial representation of what happens at different CMM level

Capability Maturity Model (CMM) & CMM Levels:

How long does it take to Implement CMM?

CMM is the most desirable process to maintain the quality of the product for any software development company, but its implementation takes little longer than what is expected.

CMM implementation does not occur overnight

It's just not merely a "paperwork."

Typical times for implementation is

3-6 months -> for preparation

6-12 months -> for implementation

3 months -> for assessment preparation

12 months ->for each new level

Internal Structure of CMM

Each level in CMM is defined into key process area or KPA, except for level-1. Each KPA defines a cluster of related activities, which when performed collectively achieves a set of goals considered vital for improving software capability

For different CMM levels, there are set of KPA's, for instance for CMM model-2, KPA are

REQM- Requirement Management

PP- Project Planning

PMC- Project Monitoring and Control

SAM- Supplier Agreement Management

PPQA-Process and Quality Assurance

CM-Configuration Management

Likewise, for other CMM models, you have specific KPA's. To know whether implementation of a KPA is effective, lasting and repeatable, it is mapped on following basis

Commitment to perform

Ability to perform

Activities perform

Measurement and Analysis

Verifying implementation

Limitations of CMM Models

CMM determines what a process should address instead of how it should be implemented

It does not explain every possibility of software process improvement

It concentrates on software issues but does not consider strategic business planning, adopting technologies, establishing product line and managing human resources

It does not tell on what kind of business an organization should be in

CMM will not be useful in the project having a crisis right now

Why Use CMM?

Today CMM act as a "seal of approval" in the software industry. It helps in various ways to improve the software quality.

It guides towards repeatable standard process and hence reduce the learning time on how to get things done

Practicing CMM means practicing standard protocol for development, which means it not only helps the team to save time but also gives a clear view of what to do and what to expect

The quality activities gel well with the project rather than thought of as a separate event

It acts as a commuter between the project and the team

CMM efforts are always towards the improvement of the process

Summary

CMM was first introduced in late 80's in U.S Air Force to evaluate the work of subcontractors. Later on, with improved version, it was implemented to track the quality of the software development system.

The entire CMM level is divided into five levels.

Level 1 (Initial): Where requirements for the system are usually uncertain, misunderstood and uncontrolled. The process is usually chaotic and ad-hoc.

Level 2 (Managed): Estimate project cost, schedule, and functionality. Software standards are defined

Level 3 (Defined): Makes sure that product meets the requirements and intended use

Level 4 (Quantitatively Managed): Manages the project's processes and sub-processes statistically

Level 5 (Maturity): Identify and deploy new tools and process improvements to meet needs and business objectives

A Process Area is a cluster of related practices in an area that, when implemented collectively, satisfy a set of goals considered important for making significant improvement in that area. All CMMI process areas are common to both continuous and staged representations.

The continuous representation enables the organization to choose the focus of its process improvement efforts by choosing those process areas, or sets of interrelated process areas, that best benefit the organization and its business objectives. Although there are some limits on what an organization can choose because of the dependencies among process areas, the organization has considerable freedom in its selection.

Once you select the process areas, you must also select how much you would like to improve the processes associated with those process areas (i.e., select the appropriate capability level). Capability levels and generic goals and practices support the improvement of processes in individual process areas.

Conversely, you will see that the staged representation encourages you to always look at process areas in the context of the maturity level to which they belong. The process areas are organized by maturity levels to reinforce this concept. When you use a process area, you use the entire process area: all goals and all practices.

The CMMI Process Areas (PAs) can be grouped into the following four categories to understand their interactions and links with one another regardless of their defined level:

Process Management

Project Management

Engineering

Support

Each process area is defined by a set of goals and practices. There are two categories of goals and practices:

Generic goals and practices: They are part of every process area.

Specific goals and practices: They are specific to a given process area.

A process area is satisfied when company processes cover all of the generic and specific goals and practices for that process area.

Generic goals and practices:

Generic goals and practices are a part of every process area.

NOTATIONS:GG --> Generic Goals and GP --> Generic Practice

GG 1 Achieve Specific Goals

GP 1.1 Perform Specific Practices

GG 2 Institutionalise a Managed Process

GP 2.1 Establish an Organizational Policy

GP 2.2 Plan the Process

GP 2.3 Provide Resources

GP 2.4 Assign Responsibility

GP 2.5 Train People

GP 2.6 Manage Configurations

GP 2.7 Identify and Involve Relevant Stakeholders

GP 2.8 Monitor and Control the Process

GP 2.9 Objectively Evaluate Adherence

GP 2.10 Review Status with Higher Level Management

GG 3 Institutionalise a Defined Process

GP 3.1 Establish a Defined Process

GP 3.2 Collect Improvement Information

GG 4 Institutionalise a Quantitatively Managed Process

GP 4.1 Establish Quantitative Objectives for the Process

GP 4.2 Stabilise Subprocess Performance

GG 5 Institutionalise an Optimising Process

GP 5.1 Ensure Continuous Process Improvement

GP 5.2 Correct Root Causes of Problems

Common Features:

The common features are attributes that indicate whether the implementation and institutionalization of a key process area is effective, repeatable, and lasting. The five common features are listed below:

Commitment to Perform: Commitment to Perform describes the actions the organization must take to ensure that the process is established and will endure. Commitment to Perform typically involves establishing organizational policies and senior management sponsorship.

Ability to Perform: Ability to Perform describes the preconditions that must exist in the project or organization to implement the software process competently. Ability to Perform typically involves resources, organizational structures, and training.

Activities Performed: Activities Performed describes the roles and procedures necessary to implement a key process area. Activities Performed typically involve establishing plans and procedures, performing the work, tracking it, and taking corrective actions as necessary.

Measurement and Analysis: Measurement and Analysis describes the need to measure the process and analyze the measurements. Measurement and Analysis typically includes examples of the measurements that could be taken to determine the status and effectiveness of the Activities Performed.

Verifying Implementation: Verifying Implementation describes the steps to ensure that the activities are performed in compliance with the process that has been established. Verification typically encompasses reviews and audits by management and software quality assurance.

The practices in the common feature Activities Performed describe what must be implemented to establish a process capability. The other practices, taken as a whole, form the basis by which an organization can institutionalize the practices described in the Activities Performed common feature.

Process Areas Detail:

The CMMI contains 22 process areas indicating the aspects of product development that are to be covered by company processes.

1. Causal Analysis and Resolution (CAR)

A Support process area at Maturity Level 5

Purpose

The purpose of Causal Analysis and Resolution (CAR) is to identify causes of defects and other problems and take action to prevent them from occurring in the future.

Specific Practices by Goal

SG 1 Determine Causes of Defects

SP 1.1 Select Defect Data for Analysis

SP 1.2 Analyze Causes

SG 2 Address Causes of Defects

SP 2.1 Implement the Action Proposals

SP 2.2 Evaluate the Effect of Changes

SP 2.3 Record Data

2. Configuration Management (CM)

A Support process area at Maturity Level 2

Purpose

The purpose of Configuration Management (CM) is to establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits.

Specific Practices by Goal

SG 1 Establish Baselines

SP 1.1 Identify Configuration Items

SP 1.2 Establish a Configuration Management System

SP 1.3 Create or Release Baselines

SG 2 Track and Control Changes

SP 2.1 Track Change Requests

SP 2.2 Control Configuration Items

SG 3 Establish Integrity

SP 3.1 Establish Configuration Management Records

SP 3.2 Perform Configuration Audits

3. Decision Analysis and Resolution (DAR)

A Support process area at Maturity Level 3

Purpose

The purpose of Decision Analysis and Resolution (DAR) is to analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria.

Specific Practices by Goal

SG 1 Evaluate Alternatives

SP 1.1 Establish Guidelines for Decision Analysis

SP 1.2 Establish Evaluation Criteria

SP 1.3 Identify Alternative Solutions

SP 1.4 Select Evaluation Methods

SP 1.5 Evaluate Alternatives

SP 1.6 Select Solutions

4. Integrated Project Management +IPPD (IPM)

A Project Management process area at Maturity Level 3

Purpose

The purpose of Integrated Project Management +IPPD (IPM) is to establish and manage the project and the involvement of the relevant stakeholders according to an integrated and defined process that is tailored from the organization's set of standard processes.

Specific Practices by Goal

SG 1 Use the Project's Defined Process

SP 1.1 Establish the Project's Defined Process

SP 1.2 Use Organizational Process Assets for Planning Project Activities

SP 1.3 Establish the Project's Work Environment

SP 1.4 Integrate Plans

SP 1.5 Manage the Project Using the Integrated Plans

SP 1.6 Contribute to the Organizational Process Assets

SG 2 Coordinate and Collaborate with Relevant Stakeholders

SP 2.1 Manage Stakeholder Involvement

SP 2.2 Manage Dependencies

SP 2.3 Resolve Coordination Issues

IPPD Addition:

SG 3 Apply IPPD Principles

SP 3.1 Establish the Project's Shared Vision

SP 3.2 Establish the Integrated Team Structure

SP 3.3 Allocate Requirements to Integrated Teams

SP 3.4 Establish Integrated Teams

SP 3.5 Ensure Collaboration among Interfacing Teams

5. Measurement and Analysis (MA)

A Support process area at Maturity Level 2

Purpose

The purpose of Measurement and Analysis (MA) is to develop and sustain a measurement capability that is used to support management information needs.

Specific Practices by Goal

SG 1 Align Measurement and Analysis Activities

SP 1.1 Establish Measurement Objectives

SP 1.2 Specify Measures

SP 1.3 Specify Data Collection and Storage Procedures

SP 1.4 Specify Analysis Procedures

SG 2 Provide Measurement Results

SP 2.1 Collect Measurement Data

SP 2.2 Analyze Measurement Data

SP 2.3 Store Data and Results

SP 2.4 Communicate Results

6. Organizational Innovation and Deployment (OID)

A Process Management process area at Maturity Level 5

Purpose

The purpose of Organizational Innovation and Deployment (OID) is to select and deploy incremental and innovative improvements that measurably improve the organization's processes and technologies. The improvements support the organization's quality and process-performance objectives as derived from the organization's business objectives.

Specific Practices by Goal

SG 1 Select Improvements

SP 1.1 Collect and Analyze Improvement Proposals

SP 1.2 Identify and Analyze Innovations

SP 1.3 Pilot Improvements

SP 1.4 Select Improvements for Deployment

SG 2 Deploy Improvements

SP 2.1 Plan the Deployment areas

SP 2.2 Manage the Deployment

SP 2.3 Measure Improvement Effects

7. Organizational Process Definition +IPPD (OPD)

A Process Management process area at Maturity Level 3

Purpose

The purpose of Organizational Process Definition +IPPD (OPD) is to establish and maintain a usable set of organizational process assets.

Specific Practices by Goal

SG 1 Establish Organizational Process Assets

SP 1.1 Establish Standard Processes

SP 1.2 Establish Life-Cycle Model Descriptions

SP 1.3 Establish Tailoring Criteria and Guidelines

SP 1.4 Establish the Organization's Measurement Repository

SP 1.5 Establish the Organization's Process Asset Library

IPPD Addition:

SG 2 Enable IPPD Management

SP 2.1 Establish Empowerment Mechanisms

SP 2.2 Establish Rules and Guidelines for Integrated Teams

SP 2.3 Balance Team and Home Organization Responsibilities

8. Organizational Process Focus (OPF)

A Process Management process area at Maturity Level 3

Purpose

The purpose of Organizational Process Focus (OPF) is to plan and implement organizational process improvement based on a thorough understanding of the current strengths and weaknesses of the organization's processes and process assets.

Specific Practices by Goal

SG 1 Determine Process Improvement Opportunities

SP 1.1 Establish Organizational Process Needs

SP 1.2 Appraise the Organization's Processes

SP 1.3 Identify the Organization's Process Improvements

SG 2 Plan and Implement Process Improvement Activities

SP 2.1 Establish Process Action Plans

SP 2.2 Implement Process Action Plans

SG 3 Deploy Organizational Process Assets and Incorporate Lessons Learned

SP 3.1 Deploy Organizational Process Assets

SP 3.2 Deploy Standard Processes

SP 3.3 Monitor Implementation

SP 3.4 Incorporate Process-Related Experiences into the Organizational Process Assets

9. Organizational Process Performance (OPP)

A Process Management process area at Maturity Level 4

Purpose

The purpose of Organizational Process Performance (OPP) is to establish and maintain a quantitative understanding of the performance of the organization's set of standard processes in support of quality and process-performance objectives, and to provide the process performance data, baselines, and models to quantitatively manage the organization's projects.

Specific Practices by Goal

SG 1 Establish Performance Baselines and Models

SP 1.1 Select Processes

SP 1.2 Establish Process Performance Measures

SP 1.3 Establish Quality and Process Performance Objectives

SP 1.4 Establish Process Performance Baselines

SP 1.5 Establish Process Performance Models

10. Organizational Training (OT)

A Process Management process area at Maturity Level 3

Purpose

The purpose of Organizational Training (OT) is to develop the skills and knowledge of people so they can perform their roles effectively and efficiently.

Specific Practices by Goal

SG 1 Establish an Organizational Training Capability

SP 1.1 Establish the Strategic Training Needs

SP 1.2 Determine Which Training Needs Are the Responsibility of the Organization

SP 1.3 Establish an Organizational Training Tactical Plan

SP 1.4 Establish Training Capability

SG 2 Provide Necessary Training

SP 2.1 Deliver Training

SP 2.2 Establish Training Records

SP 2.3 Assess Training Effectiveness

11. Product Integration (PI)

An Engineering process area at Maturity Level 3

Purpose

The purpose of Product Integration (PI) is to assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product.

Specific Practices by Goal

SG 1 Prepare for Product Integration

SP 1.1 Determine Integration Sequence

SP 1.2 Establish the Product Integration Environment

SP 1.3 Establish Product Integration Procedures and Criteria

SG 2 Ensure Interface Compatibility

SP 2.1 Review Interface Descriptions for Completeness

SP 2.2 Manage Interfaces

SG 3 Assemble Product Components and Deliver the Product

SP 3.1 Confirm Readiness of Product Components for Integration

SP 3.2 Assemble Product Components

SP 3.3 Evaluate Assembled Product Components

SP 3.4 Package and Deliver the Product or Product Component

12. Project Monitoring and Control (PMC)

A Project Management process area at Maturity Level 2

Purpose

The purpose of Project Monitoring and Control (PMC) is to provide an understanding of the project's progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan.

Specific Practices by Goal

SG 1 Monitor Project Against Plan

SP 1.1 Monitor Project Planning Parameters

SP 1.2 Monitor Commitments

SP 1.3 Monitor Project Risks

SP 1.4 Monitor Data Management

SP 1.5 Monitor Stakeholder Involvement

SP 1.6 Conduct Progress Reviews

SP 1.7 Conduct Milestone Reviews

SG 2 Manage Corrective Action to Closure

SP 2.1 Analyze Issues

SP 2.2 Take Corrective Action

SP 2.3 Manage Corrective Action

13. Project Planning (PP)

A Project Management process area at Maturity Level 2

Purpose

The purpose of Project Planning (PP) is to establish and maintain plans that define project activities.

Specific Practices by Goal

SG 1 Establish Estimates

SP 1.1 Estimate the Scope of the Project

SP 1.2 Establish Estimates of Work Product and Task Attributes

SP 1.3 Define Project Life Cycle

SP 1.4 Determine Estimates of Effort and Cost

SG 2 Develop a Project Plan

SP 2.1 Establish the Budget and Schedule

SP 2.2 Identify Project Risks

SP 2.3 Plan for Data Management

SP 2.4 Plan for Project Resources

SP 2.5 Plan for Needed Knowledge and Skills

SP 2.6 Plan Stakeholder Involvement

SP 2.7 Establish the Project Plan

SG 3 Obtain Commitment to the Plan

SP 3.1 Review Plans that Affect the Project

SP 3.2 Reconcile Work and Resource Levels

SP 3.3 Obtain Plan Commitment

14. Process and Product Quality Assurance (PPQA)

A Support process area at Maturity Level 2

Purpose

The purpose of Process and Product Quality Assurance (PPQA) is to provide staff and management with objective insight into processes and associated work products.

Specific Practices by Goal

SG 1 Objectively Evaluate Processes and Work Products

SP 1.1 Objectively Evaluate Processes

SP 1.2 Objectively Evaluate Work Products and Services

SG 2 Provide Objective Insight

SP 2.1 Communicate and Ensure Resolution of Noncompliance Issues

SP 2.2 Establish Records

15. Quantitative Project Management (QPM)

A Project Management process area at Maturity Level 4

Purpose

The purpose of the Quantitative Project Management (QPM) process area is to quantitatively manage the project's defined process to achieve the project's established quality and process-performance objectives.

Specific Practices by Goal

SG 1 Quantitatively Manage the Project

SP 1.1 Establish the Project's Objectives

SP 1.2 Compose the Defined Processes

SP 1.3 Select the Subprocesses that Will Be Statistically Managed

SP 1.4 Manage Project Performance

SG 2 Statistically Manage Subprocess Performance

SP 2.1 Select Measures and Analytic Techniques

SP 2.2 Apply Statistical Methods to Understand Variation

SP 2.3 Monitor Performance of the Selected Subprocesses

SP 2.4 Record Statistical Management Data

16. Requirements Development (RD)

An Engineering process area at Maturity Level 3

Purpose

The purpose of Requirements Development (RD) is to produce and analyze customer, product, and product-component requirements.

Specific Practices by Goal

SG 1 Develop Customer Requirements

SP 1.1 Elicit Needs

SP 1.2 Develop the Customer Requirements

SG 2 Develop Product Requirements

SP 2.1 Establish Product and Product-Component Requirements

SP 2.2 Allocate Product-Component Requirements

SP 2.3 Identify Interface Requirements

SG 3 Analyze and Validate Requirements

SP 3.1 Establish Operational Concepts and Scenarios

SP 3.2 Establish a Definition of Required Functionality

SP 3.3 Analyze Requirements

SP 3.4 Analyze Requirements to Achieve Balance

SP 3.5 Validate Requirements

17. Requirements Management (REQM)

An Engineering process area at Maturity Level 2

Purpose

The purpose of Requirements Management (REQM) is to manage the requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products.

Specific Practices by Goal

SG 1 Manage Requirements

SP 1.1 Obtain an Understanding of Requirements

SP 1.2 Obtain Commitment to Requirements

SP 1.3 Manage Requirements Changes

SP 1.4 Maintain Bidirectional Traceability of Requirements

SP 1.5 Identify Inconsistencies between Project Work and Requirements

18. Risk Management (RSKM)

A Project Management process area at Maturity Level 3

Purpose

The purpose of Risk Management (RSKM) is to identify potential problems before they occur so that risk-handling activities can be planned and invoked as needed across the life of the product or project to mitigate adverse impacts on achieving objectives.

Specific Practices by Goal

SG 1 Prepare for Risk Management

SP 1.1 Determine Risk Sources and Categories

SP 1.2 Define Risk Parameters

SP 1.3 Establish a Risk Management Strategy

SG 2 Identify and Analyze Risks

SP 2.1 Identify Risks

SP 2.2 Evaluate, Categorize, and Prioritize Risks

SG 3 Mitigate Risks

SP 3.1 Develop Risk Mitigation Plans

SP 3.2 Implement Risk Mitigation Plans

19. Supplier Agreement Management (SAM)

A Project Management process area at Maturity Level 2

Purpose

The purpose of Supplier Agreement Management (SAM) is to manage the acquisition of products from suppliers for which there exists a formal agreement.

Specific Practices by Goal

SG 1 Establish Supplier Agreements

SP 1.1 Determine Acquisition Type

SP 1.2 Select Suppliers

SP 1.3 Establish Supplier Agreements

SG 2 Satisfy Supplier Agreements

SP 2.1 Execute the Supplier Agreement

SP 2.2 Monitor Selected Supplier Processes

SP 2.3 Evaluate Selected Supplier Work Products

SP 2.4 Accept the Acquired Product

SP 2.5 Transition Products

20. Technical Solution (TS)

An Engineering process area at Maturity Level 3

Purpose

The purpose of Technical Solution (TS) is to design, develop, and implement solutions to requirements. Solutions, designs, and implementations encompass products, product components, and product-related life-cycle processes either singly or in combination as appropriate.

Specific Practices by Goal

SG 1 Select Product-Component Solutions

SP 1.1 Develop Alternative Solutions and Selection Criteria

SP 1.2 Select Product Component Solutions

SG 2 Develop the Design

SP 2.1 Design the Product or Product Component

SP 2.2 Establish a Technical Data Package

SP 2.3 Design Interfaces Using Criteria

SP 2.4 Perform Make, Buy, or Reuse Analysis

SG 3 Implement the Product Design

SP 3.1 Implement the Design

SP 3.2 Develop Product Support Documentation

21. Validation (VAL)

An Engineering process area at Maturity Level 3

Purpose

The purpose of Validation (VAL) is to demonstrate that a product or product component fulfills its intended use when placed in its intended environment.

Specific Practices by Goal

SG 1 Prepare for Validation

SP 1.1 Select Products for Validation

SP 1.2 Establish the Validation Environment

SP 1.3 Establish Validation Procedures and Criteria

SG 2 Validate Product or Product Components

SP 2.1 Perform Validation

SP 2.2 Analyze Validation Results.

22. Verification (VER)

An Engineering process area at Maturity Level 3

Purpose

The purpose of Verification (VER) is to ensure that selected work products meet their specified requirements.

Specific Practices by Goal

SG 1 Prepare for Verification

SP 1.1 Select Work Products for Verification

SP 1.2 Establish the Verification Environment

SP 1.3 Establish Verification Procedures and Criteria

SG 2 Perform Peer Reviews

SP 2.1 Prepare for Peer Reviews

SP 2.2 Conduct Peer Reviews

SP 2.3 Analyze Peer Review Data

SG 3 Verify Selected Work Products

SP 3.1 Perform Verification

SP 3.2 Analyze Verification Results

Difference between ISO9000 and SEI-CMM

**ISO 9000:**  
It is a set of International Standards on quality management and quality assurance developed to help companies effectively document the quality system elements needed to an efficient quality system.

**SEICMM:**  
SEI (Software Engineering Institute), Capability Maturity Model (CMM) specifies an increasing series of levels of a software development organization.

**Difference between ISO9000 and SEI-CMM:**

| ISO 9000 | SEICMM |
| --- | --- |
| ISO 9000 is a set of international standarads on quality management and quality assurance developed to help companies effectively document the quality system elements needed to an efficient quality system. | SEI (Software Engineering Institute), Capability Maturity Model (CMM) specifies an increasing series of levels of a software development organization. |
| Focus is customer supplier relationship, attempting to reduce customer’s risk in choosing a supplier. | Focus on the software supplier to improve its interval processes to achieve a higher quality product for the benefit of the customer. |
| It is created for hard goods manufacturing industries. | It is created for software industry. |
| ISO9000 is recognized and accepted in most of the countries. | SEICMM is used in USA, less widely elsewhere. |
| It specifies concepts, principles and safeguards that should be in place. | CMM provides detailed and specific definition of what is required for given levels. |
| This establishes one acceptance level. | It assesses on 5 levels. |
| Its certification is valid for three years. | It has no limit on certification. |
| It focuses on inwardly processes. | It focus outwardly. |
| It has no level. | It has 5 levels:  **(a).** Initial  **(b).** Repeatable  **(c).** Defined  **(d).** Managed  **(e).** Optimized |
| It is basically an audit. | It is basically an appraisal. |
| It is open to multi sector. | It is open to IT/ITES. |
| Follow set of standards to make success repeatable. | It emphasizes a process of continuous improvement. |

Total Quality Management

Total Quality management is defined as a continuous effort by the management as well as employees of a particular organization to ensure long term customer loyalty and customer satisfaction. Remember, one happy and satisfied customer brings ten new customers along with him whereas one disappointed individual will spread bad word of mouth and spoil several of your existing as well as potential customers.

Risk management

Risk management is the process of identifying, assessing and controlling threats to an organization's capital and earnings. These threats, or risks, could stem from a wide variety of sources, including financial uncertainty, legal liabilities, strategic management errors, accidents and natural disasters. IT security threats and data-related risks, and the risk management strategies to alleviate them, have become a top priority for digitized companies. As a result, a risk management plan increasingly includes companies' processes for identifying and controlling threats to its digital assets, including proprietary corporate data, a customer's personally identifiable information (PII) and intellectual property.

Every business and organization faces the risk of unexpected, harmful events that can cost the company money or cause it to permanently close. Risk management allows organizations to attempt to prepare for the unexpected by minimizing risks and extra costs before they happen.

Risk Management is Evolving, Don’t Fall Behind

Download now for advice to help you improve accuracy of security questionnaires, interview third-party employees about risk and rethink third-party risk management best practices, and more.

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Importance

By implementing a risk management plan and considering the various potential risks or events before they occur, an organization can save money and protect their future. This is because a robust risk management plan will help a company establish procedures to avoid potential threats, minimize their impact should they occur and cope with the results. This ability to understand and control risk enables organizations to be more confident in their business decisions. Furthermore, strong corporate governance principles that focus specifically on risk management can help a company reach their goals.

Other important benefits of risk management include:

Creates a safe and secure work environment for all staff and customers.

Increases the stability of business operations while also decreasing legal liability.

Provides protection from events that are detrimental to both the company and the environment.

Protects all involved people and assets from potential harm.

Helps establish the organization's insurance needs in order to save on unnecessary premiums.

The importance of combining risk management with patient safety has also been revealed. In most hospitals and organizations, the risk management and patient safety departments are separated; they incorporate different leadership, goals and scope. However, some hospitals are recognizing that the ability to provide safe, high-quality patient care is necessary to the protection of financial assets and, as a result, should be incorporated with risk management.

In 2006, the Virginia Mason Medical Center in Seattle, Washington integrated their risk management functions into their patient safety department, ultimately creating the Virginia Mason Production System (VMPS) management methods. VMPS focuses on continuously improving the patient safety system by increasing transparency in risk mitigation, disclosure and reporting. Since implementing this new system, Virginia Mason has experienced a significant reduction in hospital professional premiums and a large increase in the reporting culture.

Risk management strategies and processes

All risk management plans follow the same steps that combine to make up the overall risk management process:

Establish context. Understand the circumstances in which the rest of the process will take place. The criteria that will be used to evaluate risk should also be established and the structure of the analysis should be defined.

Risk identification. The company identifies and defines potential risks that may negatively influence a specific company process or project.

Risk analysis. Once specific types of risk are identified, the company then determines the odds of them occurring, as well as their consequences. The goal of risk analysis is to further understand each specific instance of risk, and how it could influence the company's projects and objectives.

Risk assessment and evaluation. The risk is then further evaluated after determining the risk's overall likelihood of occurrence combined with its overall consequence. The company can then make decisions on whether the risk is acceptable and whether the company is willing to take it on based on its risk appetite.

Risk mitigation. During this step, companies assess their highest-ranked risks and develop a plan to alleviate them using specific risk controls. These plans include risk mitigation processes, risk prevention tactics and contingency plans in the event the risk comes to fruition.

Risk monitoring. Part of the mitigation plan includes following up on both the risks and the overall plan to continuously monitor and track new and existing risks. The overall risk management process should also be reviewed and updated accordingly.

Communicate and consult. Internal and external shareholders should be included in communication and consultation at each appropriate step of the risk management process and in regards to the process as a whole.

Risk management strategies should also attempt to answer the following questions:

What can go wrong? Consider both the workplace as a whole and individual work.

How will it affect the organization? Consider the probability of the event and whether it will have a large or small impact.

What can be done? What steps can be taken to prevent the loss? What can be done recover if a loss does occur?

If something happens, how will the organization pay for it?

Risk management approaches

After the company's specific risks are identified and the risk management process has been implemented, there are several different strategies companies can take in regard to different types of risk:

Risk avoidance. While the complete elimination of all risk is rarely possible, a risk avoidance strategy is designed to deflect as many threats as possible in order to avoid the costly and disruptive consequences of a damaging event.

Risk reduction. Companies are sometimes able to reduce the amount of damage certain risks can have on company processes. This is achieved by adjusting certain aspects of an overall project plan or company process, or by reducing its scope.

Risk sharing. Sometimes, the consequences of a risk are shared, or distributed among several of the project's participants or business departments. The risk could also be shared with a third party, such as a vendor or business partner.

Risk retaining. Sometimes, companies decide a risk is worth it from a business standpoint, and decide to keep the risk and deal with any potential fallout. Companies will often retain a certain level of risk if a project's anticipated profit is greater than the costs of its potential risk.

Limitations

While risk management can be an extremely beneficial practice for organizations, its limitations should also be considered. Many risk analysis techniques -- such as creating a model or simulation -- require gathering large amounts of data. This extensive data collection can be expensive and is not guaranteed to be reliable.

Furthermore, the use of data in decision making processes may have poor outcomes if simple indicators are used to reflect the much more complex realities of the situation. Similarly, adopting a decision throughout the whole project that was intended for one small aspect can lead to unexpected results.

Another limitation is the lack of analysis expertise and time. Computer software programs have been developed to simulate events that might have a negative impact on the company. While cost effective, these complex programs require trained personnel with comprehensive skills and knowledge in order to accurately understand the generated results. Analyzing historical data to identify risks also requires highly trained personnel. These individuals may not always be assigned to the project. Even if they are, there frequently is not enough time to gather all their findings, thus resulting in conflicts.

Other limitations include:

A false sense of stability. Value-at-risk measures focus on the past instead of the future. Therefore, the longer things go smoothly, the better the situation looks. Unfortunately, this makes a downturn more likely.

The illusion of control. Risk models can give organizations the false belief that they can quantify and regulate every potential risk. This may cause an organization to neglect the possibility of novel or unexpected risks. Furthermore, there is no historical data for new products, so there's no experience to base models on.

Failure to see the big picture. It's difficult to see and understand the complete picture of cumulative risk.

Risk management is immature. An organization's risk management policies are underdeveloped and lack the history to make accurate evaluations.

Risk management standards

Since the early 2000s, several industry and government bodies have expanded regulatory compliance rules that scrutinize companies' risk management plans, policies and procedures. In an increasing number of industries, boards of directors are required to review and report on the adequacy of enterprise risk management processes. As a result, risk analysis, internal audits and other means of risk assessment have become major components of business strategy.

Risk management standards have been developed by several organizations, including the National Institute of Standards and Technology (NIST) and the International Organization for Standardization (ISO). These standards are designed to help organizations identify specific threats, assess unique vulnerabilities to determine their risk, identify ways to reduce these risks and then implement risk reduction efforts according to organizational strategy.

The ISO 31000 principles, for example, provide frameworks for risk management process improvements that can be used by companies, regardless of the organization's size or target sector. The ISO 31000 is designed to "increase the likelihood of achieving objectives, improve the identification of opportunities and threats, and effectively allocate and use resources for risk treatment," according to the ISO website. Although ISO 31000 cannot be used for certification purposes, it can help provide guidance for internal or external risk audit, and it allows organizations to compare their risk management practices with the internationally recognized benchmarks.

The ISO recommends the following target areas, or principles, should be part of the overall risk management process:

The process should create value for the organization.

It should be an integral part of the overall organizational process.

It should factor into the company's overall decision-making process.

It must explicitly address any uncertainty.

It should be systematic and structured.

It should be based on the best available information.

It should be tailored to the project.

It must take into account human factors, including potential errors.

It should be transparent and all-inclusive.

It should be adaptable to change.

It should be continuously monitored and improved upon.

The ISO standards and others like it have been developed worldwide to help organizations systematically implement risk management best practices. The ultimate goal for these standards is to establish common frameworks and processes to effectively implement risk management strategies.

These standards are often recognized by international regulatory bodies, or by target industry groups. They are also regularly supplemented and updated to reflect rapidly changing sources of business risk. Although following these standards is usually voluntary, adherence may be required by industry regulators or through business contracts.

Risk management examples

One example of risk management could be a business identifying the various risks associated with opening a new location. They can mitigate risks by choosing locations with a lot of foot traffic and low competition from similar businesses in the area.

Another example could be an outdoor amusement park that acknowledges their business is completely weather-dependent. In order to alleviate the risk of a large financial hit whenever there is a bad season, the park might choose to consistently spend low and build up cash reserves.

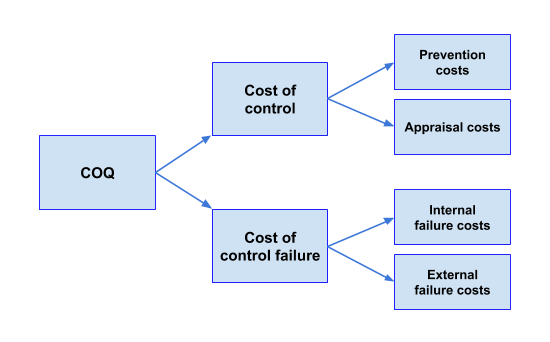
Yet another example could be an investor buying stock in an exciting new company with high valuation even though they know the stock could significantly drop. In this situation, risk acceptance is displayed as the investor buys despite the threat, feeling the potential of the large reward outweighs the risk.

Defining the COQ

Overall, the term cost of quality (COQ) is a means to sum up product quality-related costs (control, detection, prevention) and defect-related costs (failure, non-conformance, deficiencies). By doing this, company management can evaluate the soundness of investments into quality. The concept was first introduced by [Armand Feigenbaum](https://en.wikipedia.org/wiki/Armand_V._Feigenbaum) in 1956.

Simply put, COQ is extra expenses, beyond production costs, to ensure the quality end-product. The Cost of Quality includes prevention, appraisal, and correction or repair costs. COQ is split into two groups: cost of control and cost of failure of control, with each further split into two sub-categories.

**Cost of control** includes prevention cost (to prevent defects) and appraisal cost (to detect defects), while **cost of failure** of control consists of internal failure and external failure costs.

[](https://brainhub.eu/blog/wp-content/uploads/2018/08/cost-of-quality-in-software-development-coq.png)

Thus, a formula for COQ calculation is simple:  
**Cost of control + cost of failure of control = COQ**

Regarding the cost of quality in software development, it isn’t as sophisticated and established a practice as compared to the COQ adopted in manufacturing and other fields. While in manufacturing cost components are visible and classifiable, the debate over how to measure quality-associated costs in software development is still ongoing.

Post-launch defects, a.k.a. software bugs, are much too common and difficult to eradicate in the software industry still, therefore the question remains open – is it worth applying COQ in software development?

The cost of quality in software development

COQ in the software development world refers to the costs teams are investing to ensure their products/services are of high quality and defect-free. Today’s software is remarkably complex, comprises thousands of lines of code, and a huge amount of errors (aka ‘bugs’).

That’s why companies must invest in costs- in form of resources and activities – throughout the lifecycle, to prevent failures; and considering that about 70-80% of development costs are usually spent on correcting bugs, we arrive at the conclusion that the **cost of quality in software development is really important**.

Let’s see what the aforementioned four groups of COQ typically represent in terms of the software development life cycle:

* External failure costs – linked to defects the customer finds post-sale, e.g. costs to process customer complaints, returns, warranty claims.
* Internal failure costs – linked to defects found before selling the product to customers, e.g. re-work, re-testing, bug fixing, re-design.
* Appraisal costs – incurred to determine conformance to quality requirements, e.g. measurements, audits, evaluations, inspections, testing.
* Prevention costs – incurred to prevent bad quality, e.g. quality planning, project management, feature review, product review, Agile and process review, team training.

A template for evaluating COQ in software development would look something like this table:

|  | |  | |  | |
| --- | --- | --- | --- | --- | --- |
|  | |  | |  | |
| Project activity | | Hours | | Part of COQ | |
| Training | | X hours | | Prevention costs | |
| Requirements review | | X hours | | Appraisal costs | |
| Requirements re-do | | X hours | | Internal failure costs | |
| Code review | | X hours | | Appraisal costs | |
| Coding re-do | | X hours | | Internal failure costs | |
| Design review | | X hours | | Appraisal costs | |
| Testing | | X hours | | Appraisal costs | |

Note: COQ is important, yet at the same time, it should rather be kept pragmatic in relation to project goals, otherwise it can lead to significant overhead costs to the budget. As only few projects start with certainty in requirements and costs, somewhere between facts and guesswork there are **assumptions** and **constraints** in use as factors helping define realistic results.

In plain words, assumptions refer to capabilities, and constraints refer to limitations, which in project planning usually help envision schedules, resources, costs, procedures, etc.

After investing into COQ for software projects, one may be able to evaluate the following:

* The share of cost of quality in software development out of total costs;
* Percentage of failure costs out of total development costs;
* The share of cost of software quality out of total sales and maintenance.

Bottom line: in software development quality should be planned and implemented, not inspected afterwards. The reason is in clear sight – the cost of preventing errors is less than the cost of correcting errors found on final stages or by customer complaints. One can calculate COQ in terms of effort (hours or days), in terms of money (by converting the effort into cost), or as a percentage of total cost.

Quality requires additional costs

The issue of cost of quality in software development is about balance, as with many other aspects. Quality management creates adds extra costs and time, and, if not addressed, could potentially become a point of failure. A practical and beneficial COQ would be the one aligned with project requirements and quality goals, preventing defects and not exceeding the budget.

This means, while quality is really crucial, it **doesn’t need to be attained in every feature** down to each detail. In this quest to minimize costs without compromising quality, a good starting point is finding the spot at which cost of control can ensure targeted results without going overhead. Apropos, solving such a balancing act could be one of the traits of [a skilled CTO](https://brainhub.eu/blog/cto-coder-and-smart-guy/).

Further on, some of the questions to consider:

* What are your goals for process and project quality?
* What are your anticipated project results and what practices are used to obtain them?
* How would you define and measure quality?
* If quality goals aren’t obtained, what would the consequences be?
* What quality management activities can you apply and how much would they cost or add to the budget?
* What is of higher priority: overhead costs for quality or a risk of defects for the sake of faster delivery/lower costs?

Hypothetical case**evaluation**

On account of COQ practicality, let’s conduct a small hypothetical case evaluation.

Say, we are developing a mobile app with 2 scenarios: with and without quality management. In each case, we’re dealing with 200 errors (bugs) total, and assume a $20 price to fix a bug found internally, while a $100 price to fix a bug found externally.

*First case – no quality management*

In the first case, without quality management in place, COQ investment is zero, and we only spend money to fix bugs.

Say, we found 50 bugs internally, and 150 were reported by customers after they used the app.

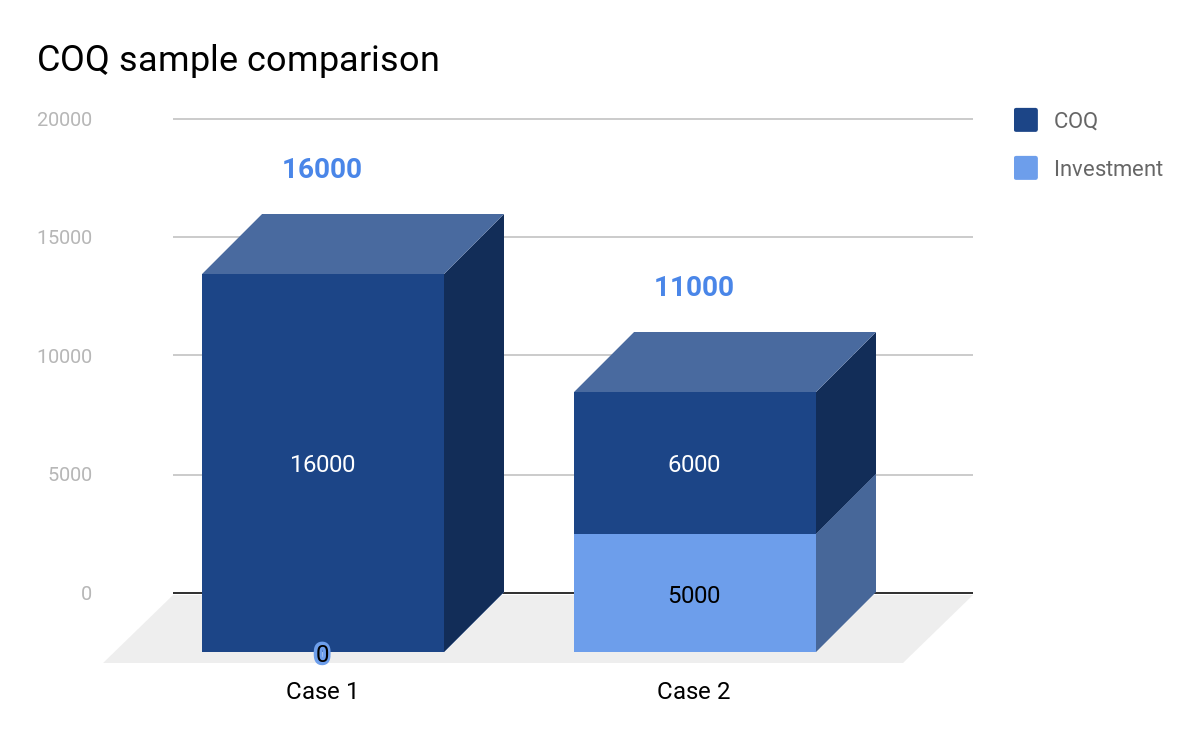
Total COQ would equal (50\*$20)+(150\*$100)=**$16,000**.

*Second case – 100 h for quality management*

In the second case, let’s assume we spend 100 additional hours on quality management procedures. Thus, at the average $50 hourly developer rate, we invest about $5,000 in software quality.

As a result, we detect more bugs internally – 175, lower external bugs to 25.

The total COQ equals $5,000+((175\*$20)+(25\*$100))= **$11,000**.

[](https://brainhub.eu/blog/wp-content/uploads/2018/08/cost-of-quality-in-software-development-comparison.png)

As we see, the total cost of quality is in favor of the second case. Although this is neither an ultimate equation and the figures aren’t exact, it’s possible to conclude that if you invest in essential features of a product and you build and ensure real quality there, then COQ in [software development](https://brainhub.eu/mobile-app-developers) is really worth considering.

For final disclosure, we should note that most IT-companies end up with 15-20% quality-related costs out of total sales revenue, and few of them spend even more. A rule of thumb for efficient and profitable workflow would be 10 to 15%.